REMARKS AND ARGUMENTS

Claims 40 and 71 have been amended and claims 41, 42, and 73 have been canceled. The application contains pending claims 40, 43-51, and 68-72.

Claims 40-51 and 68-72 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Yamamoto in view of Akram and "admitted prior art" (hereinafter "APA"). Claim 73 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Yamamoto in view of Akram and APA. The rejections are respectfully traversed.

The Office Action states that Yamamoto discloses a semiconductor device comprising a metal contact formed on the surface thereof; a first insulator layer overlying the metal contact; a metal pad overlying the first insulator layer and in contact with the metal contact; a second insulator layer overlying the metal pad; and a solder ball formed in the second insulator layer and in contact with the metal pad. The Office Action further states that Akram discloses solder microbumps having a diameter of 15-100 microns and that the APA discloses using solder balls of 100 micron diameter in C4 bonding of an integrated circuit to a substrate. The Office Action concludes that it would have been obvious to one of ordinary skill in the art at the time the claimed invention was made to use the microbumps from Akram in Yamamoto's device to obtain the claimed invention.

Applicant respectfully submits that there was no motivation at the time the claimed invention was made to combine these references, and that the combination of these references therefore is improper. The claimed invention is directed to on-die solder contacts that are at least two orders of magnitude smaller than prior art on-die solder contacts (Specification page 5, lines 1 to 10). Yamamoto discloses solder bumps with no disclosure of size. The APA discloses conventional on-die solder balls having a size of 100 microns or greater. Akram does not disclose <u>any</u> on-die solder bumps. Instead, Akram discloses solder bumps on a support member which <u>receives a die</u>. Thus, none of the cited references teaches or suggests on-die solder balls having diameter of less than 100 microns. As noted in the specification, the use of larger solder balls (100 microns or greater) impacts

on the number and density of I/O terminals which can be provided on a die. The claimed invention allows for a higher density of I/O terminals on a die of a given size.

The Office Action points to Akram for its teaching of using off-die solder balls of 15-100 microns. However, this does not teach using solder balls of this size on-die. Moreover, there is no teaching or suggestion within Akram on how one would fabricate solder balls of this size on-die. Only Applicant has disclosed a workable technique for doing so.

Still further, claims 40 and 71 have been amended to claim semiconductor devices comprising at least one solder contact having a diameter less than 15 microns, a limitation not disclosed even in Akram. An altering of the numerical range limitations of the original claims is proper if "one skilled in the art would consider [the new range] inherently supported by the discussion in the original disclosure." MPEP § 2163.05(III) (citing In re Wertheim, 541 F.2d 257, 191 USPQ 90 (CCPA 1976) (holding that a range limitation to "between 35% and 60%" met the description requirement where the ranges described in the original specification included a range of "25%-60%")). As the new range limitations recited in the amended claims are fully supported by the original disclosure, these amendments are proper.

The Office Action also states that:

> Akram further teaches using the microbumps having mushroom/hemispherical shaped top/tip portion where the total height (Fig. 1C and 3) is in the range of 1-60 microns and the diameter of the microbumps being smaller than the pad dimension (Col. 5, line 1-16). The Fig. 1C and 3 Akram show the dimensions and the relative comparison of the total height and diameter of the microbumps and pad dimension. It would be obvious to a person of ordinary skill in the art to realize that the microbumps can have the diameter in a range of 1-60 microns.

Applicant respectfully submits otherwise. First, Akram discloses 15 microns as the lower limit for the diameter of the solder bumps even while explicitly taking into account the

dimensions of the bond pads: A "representative outside diameter for the tip portions of the microbumps 30 can be from 15-100 μm depending on the size of the bond pads 38 (FIG. 3)." (Col. 5, lines 18-22). Therefore, Applicant disagrees with the proposition that the teaching of solder bumps with a diameter less than that of the bond pads necessarily teaches solder bumps with a diameter of less than 15 microns.

Further, Applicant disagrees that the stated range of the heights of the disclosed microbumps can be properly combined with an inferred microbump shape and an imputed proportionality to render the present invention obvious. While Akram does states that the height of the solder microbumps can be from 1-60 microns, there is no indication whatever that the diameter of the solder microbumps in Akram is a function of their height. Thus, given a range of possible heights, no inferences about disclosed microbump diameters can be drawn.

Applicant also submits that the disclosure in Akram of solder microbumps having a diameter of 15-100 microns does not render obvious the solder contacts of the present invention which have a diameter less than 15 microns. As the Federal Circuit has stated: "In order to render a claimed apparatus or method obvious, the prior art must enable one skilled in the art to make and use the apparatus or method." Beckman Instruments, Inc. v. LKB Produkter AB, 892 F.2d 1547, 1551, 13 USPQ2d 1301, 1304 (Fed. Cir. 1989) (citing In re Payne, 606 F.2d 303, 314, 203 USPQ 245, 255 (CCPA 1979) ("References relied upon to support a rejection under 35 USC 103 must provide an enabling disclosure, i.e., they must place the claimed invention in the possession of the public. An invention is not 'possessed' absent some known or obvious way to make it.") (citations omitted)). The Federal Circuit recently reiterated this proposition in Motorola Inc. v. Interdigital Technology Corp., 121 F.3d 1461, 1472, 43 USPQ2d 1481, 1489 (Fed. Cir. 1997) (quoting Beckman, supra). Here, only Applicant has disclosed how to form such small solder balls on a die. Akram recognizes that "the manufacturing process for the microbumps is complicated and requires specialized manufacturing equipment." (Col. 1, lines 40-42). "The present invention is directed to a simplified method for forming

microbump interconnects directly on a rigid substrate." (Col. 1, lines 54-56). Nowhere does Akram teach how to provide solder bumps less than 15 microns in diameter on a die. Accordingly, there is no motivation, teaching or suggestion in Akram for reducing the diameter to less than 15 microns.

In light of the foregoing amendments and reasons, claims 40 and 71 are allowable over the cited combination. Claims 43-51, and 68-70 depend from claim 40 and are allowable along with claim 40. Claim 72 depends from claim 71 and is allowable along with claim 71. Claim 73 has been canceled, thereby rendering the rejection of that claim moot. Accordingly, the rejections should be withdrawn and the claims allowed.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue.

Dated: July 25, 2002

Respectfully submitted,

By_____

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Version With Markings to Show Changes Made

40. (Amended) A semiconductor device comprising:

a semiconductor structure having at least one metal contact formed on a surface thereof;

a first insulator layer overlying said at least one metal contact;

at least one metal pad overlying said first insulator layer and in contact with said at least one metal contact;

a second insulator layer overlying said at least first one metal pad; and,

at least one solder contact formed in the second insulator and in contact with said at least one metal pad, said solder contact having a diameter less than 15 [100] microns.

71. (Amended) A semiconductor device formed on a semiconductor substrate having at least one metal contact formed thereon, said semiconductor device comprising:

a first insulator layer overlying said at least one metal contact;

at least one metal pad overlying said first insulator layer and in contact with said at least one metal contact;

a second insulator layer overlying said at least first one metal pad; and

at least one solder contact formed in the second insulator and in contact with said at least one metal pad, said solder contact having a diameter between 2 and 15 [100] microns.